

working places A, B, C, shown in the accompanying plan, and early in the present year that I could get into those marked D, E. With the exception of some burnt hay or dried grass which I found at the point X in one of the return air-ways, I saw no traces of burning nor deposits of coked coal-dust in any of the main roadways, but I found well-marked deposits of coked coal-dust in all the working places in both districts of workings as far as I was able to penetrate. The plan shows that the current of fresh air which came down the down-cast shaft was split up into three separate currents at the points K and L. The districts A, B, C, and D, E, were thus ventilated quite independently of each other, and thus it was impossible for any out-burst of fire-damp which might take place in one of them to affect the quality of the air in the other.

We are thus compelled to fall back upon some other mode of explanation in this case, and I now submit that in the present, and in my previous papers, I have brought forward sufficient evidence to show that the coal-dust hypothesis is the only tenable one. If it be admitted, however, that this hypothesis is applicable to Dinas explosion, the conclusion is inevitable that, *cæteris paribus*, it is equally applicable to every case of the same kind that has ever occurred.

III. "Observations on the Ingesta and Egesta of Mr. Edward Payson Weston during his Walk of 5,000 miles in 100 days. By A. WYNTER BLYTH, Medical Officer of Health for St. Marylebone. Communicated by B. W. RICHARDSON, M.D., F.R.S. Received April 30, 1884.

On the 15th day of March, 1884, Mr. Edward P. Weston finished successfully a pedestrian feat, which consisted in walking 50 miles a day, Sundays excepted, until he had traversed 5,000 miles.

The last 300 miles were walked on a level track in the Victoria Hall; and frequent observations of the pedestrian's pulse and respiration, &c., were made during six days by Mr. Green, M.R.C.S., acting under the instructions of a Committee, the active members of whom were Dr. B. W. Richardson and Dr. Ridge. Mr. Green also made some volumetric determinations of urea for the purposes of his clinical report; and he measured the urine, preserved the fæces, and weighed or measured all the food, whether liquid or solid.

Day by day I received the urine for detailed analysis, and at the termination of the walk I also received a jar containing the fæces collected during the five days ending at midnight, Saturday, 15th March.

Table I.—Giving the Details of the various Foods consumed by Mr. Weston during each of the Six Days he was under scientific Observation.

|                       | Bread-stuffs and starchy foods. |            |         |          |                 |                     |           | Fat.  | Nitrogenous foods. |         |             |             |                  |       | Fruit. | Liquids.     |                  |        |        |                                |
|-----------------------|---------------------------------|------------|---------|----------|-----------------|---------------------|-----------|-------|--------------------|---------|-------------|-------------|------------------|-------|--------|--------------|------------------|--------|--------|--------------------------------|
|                       | Oatmeal<br>porridge.            | Dry toast. | Bread.  | Muffins. | Sponge<br>cake. | Tapioea<br>pudding. | Potatoes. |       | Cabbage.           | Butter. | Fish (cod). | Roast beef. | Roast<br>mutton. | Eggs. |        | Meat waters. | Mutton<br>broth. | Milk.  | Figs.  | Zoedone,<br>ginger ale,<br>&c. |
| Monday—               |                                 |            |         |          |                 |                     |           |       |                    |         |             |             |                  |       |        |              |                  |        |        |                                |
| Breakfast.....        | 75·46                           | 56·67      | ...     | ...      | ...             | 340·2               | 113·4     | 141·7 | 56·7               | ...     | 311·8       | ...         | ...              | ...   | 453·4  | 233·5        | 99·2             | 481·9  | 453·5  | 1162·3                         |
| Lunch and dinner..... | ...                             | 42·50      | 293·4   | ...      | 56·69           | 226·8               | ...       | ...   | ...                | ...     | ...         | ...         | ...              | ...   | ...    | ...          | ...              | ...    | ...    | ...                            |
| Supper .....          | ...                             | ...        | ...     | ...      | ...             | ...                 | ...       | ...   | ...                | 36·84   | 269·3       | 184·2       | ...              | ...   | ...    | ...          | ...              | ...    | ...    | ...                            |
| Tuesday—              |                                 |            |         |          |                 |                     |           |       |                    |         |             |             |                  |       |        |              |                  |        |        |                                |
| Breakfast.....        | 81·62                           | 56·67      | 193·4   | 85·0     | ...             | 340·2               | 113·4     | 141·7 | ...                | ...     | ...         | ...         | 2                | ...   | 340·0  | ...          | 63·76            | 566·9  | 425·2  | 652·0                          |
| Lunch and dinner..... | ...                             | 56·67      | ...     | ...      | 56·69           | 226·8               | ...       | ...   | ...                | ...     | ...         | ...         | ...              | ...   | ...    | ...          | ...              | ...    | ...    | ...                            |
| Supper .....          | ...                             | 56·67      | ...     | ...      | ...             | ...                 | ...       | ...   | ...                | ...     | ...         | ...         | ...              | ...   | ...    | ...          | ...              | ...    | ...    | ...                            |
| Wednesday—            |                                 |            |         |          |                 |                     |           |       |                    |         |             |             |                  |       |        |              |                  |        |        |                                |
| Breakfast.....        | 125·85                          | 42·50      | ...     | 121·9    | ...             | 198·4               | 83·0      | 113·4 | 59·52              | 226·8   | 184·2       | ...         | ...              | ...   | 425·2  | 141·7        | 85·04            | 566·9  | 680·4  | 1020·1                         |
| Lunch and dinner..... | ...                             | 56·67      | 317·78  | ...      | 56·69           | 283·5               | ...       | ...   | ...                | ...     | ...         | ...         | ...              | ...   | ...    | ...          | ...              | ...    | ...    | ...                            |
| Supper .....          | ...                             | 56·67      | ...     | ...      | ...             | ...                 | ...       | ...   | ...                | ...     | ...         | ...         | ...              | 28·35 | 425·2  | ...          | ...              | ...    | ...    | ...                            |
| Thursday—             |                                 |            |         |          |                 |                     |           |       |                    |         |             |             |                  |       |        |              |                  |        |        |                                |
| Breakfast.....        | 106·87                          | 56·67      | 280·90  | ...      | 56·69           | 255·14              | 113·4     | 113·4 | 56·69              | 226·8   | 212·5       | ...         | ...              | ...   | 425·2  | ...          | 85·04            | 108·7  | 425·2  | 850·4                          |
| Lunch and dinner..... | ...                             | 63·75      | 433·1   | ...      | 56·69           | 581·16              | ...       | ...   | ...                | ...     | ...         | ...         | ...              | ...   | ...    | ...          | ...              | ...    | ...    | ...                            |
| Supper .....          | ...                             | ...        | ...     | ...      | ...             | ...                 | ...       | ...   | ...                | ...     | ...         | ...         | ...              | ...   | ...    | ...          | ...              | ...    | ...    | ...                            |
| Friday—               |                                 |            |         |          |                 |                     |           |       |                    |         |             |             |                  |       |        |              |                  |        |        |                                |
| Breakfast.....        | 106·87                          | 56·67      | ...     | 97·5     | ...             | 340·20              | 97·2      | 113·4 | 77·94              | 226·8   | 212·5       | ...         | ...              | ...   | 340·0  | ...          | 70·8             | 1133·9 | ...    | 1644·3                         |
| Lunch and dinner..... | ...                             | 63·75      | 433·1   | ...      | 56·69           | 269·30              | ...       | ...   | ...                | ...     | ...         | ...         | ...              | ...   | ...    | ...          | ...              | ...    | ...    | ...                            |
| Supper .....          | ...                             | ...        | ...     | ...      | ...             | ...                 | ...       | ...   | ...                | ...     | ...         | ...         | ...              | ...   | ...    | ...          | ...              | ...    | ...    | ...                            |
| Saturday—             |                                 |            |         |          |                 |                     |           |       |                    |         |             |             |                  |       |        |              |                  |        |        |                                |
| Breakfast.....        | 119·34                          | 42·51      | ...     | ...      | ...             | 333·0               | 113·4     | 141·7 | 45·62              | ...     | ...         | 191·3       | 4                | ...   | 425·2  | ...          | ...              | 1275·6 | 510·3  | 680·4                          |
| Lunch and dinner..... | ...                             | 56·67      | 293·4   | ...      | ...             | ...                 | ...       | ...   | ...                | ...     | ...         | ...         | ...              | ...   | ...    | ...          | ...              | ...    | ...    | ...                            |
| Supper .....          | ...                             | 56·67      | ...     | ...      | ...             | ...                 | ...       | ...   | ...                | ...     | ...         | ...         | ...              | ...   | ...    | ...          | ...              | ...    | ...    | ...                            |
| Sunday—               |                                 |            |         |          |                 |                     |           |       |                    |         |             |             |                  |       |        |              |                  |        |        |                                |
| Breakfast.....        | 616·01                          | 701·29     | 1811·98 | 304·4    | 283·45          | 3394·7              | 633·8     | 765·3 | 333·31             | 949·7   | 921·0       | 375·5       | 9                | 23·35 | 2409·0 | 425·2        | 403·8            | 4133·9 | 2494·6 | 5009·5                         |

Dr. Richardson has published elsewhere\* an account of the results of the general clinical observations, and it suffices to remark, that the pedestrian during the whole time enjoyed the most robust health, and at the termination of the walk was apparently in no way the worse for the continuous exertion of so many months.

My own part in the observations on Weston has been the analysis of the egesta and the calculation of the food equivalents. The latter have been, for the most part, based upon analyses in my own work on "Food," supplemented by the mean numbers given in König's "Nahrungsmittel," and in two instances by analyses of the actual foods consumed.†

*The Food taken. Ingesta.*

The bulk of the food was taken in three meals—breakfast, dinner, and supper. Carbohydrates were supplied chiefly through porridge, bread-stuffs, potatoes, and tapioca pudding; albuminoids through eggs, fish, lean beef or mutton; some fat was taken in the shape of butter, and there was a copious supply of liquids by means of mutton broth, tea, coffee, and aerated waters; it is also noticeable that each day a certain number of figs were eaten. Table I (p. 47) gives the amounts of the various constituents in grams and cubic centimetres.

In Table II the somewhat complicated diet is reduced to "food equivalents."

The last day, Saturday, was in some points not comparable with the others; besides which, we have the results of an analysis of the solid excreta‡ corresponding to the food of the five days, from Monday to Friday inclusive, so that it is best to take the average of the five days previous to Saturday, and this average may be compared with any standard diet which would keep a man of Weston's weight in health during ordinary labour.

\* The "Asclepiad," No. 2, vol. i, p. 166, *et seq.*

† *E.g.*, the pudding (of which so much was taken) referred to in Table I as tapioca pudding I found to contain—

|                    |        |
|--------------------|--------|
| Water .....        | 31·00  |
| Albuminoids .....  | 7·72   |
| Carbohydrates..... | 61·04  |
| Fat .....          | 0·21   |
| Ash .....          | 0·03   |
|                    | <hr/>  |
|                    | 100·00 |

The sponge cake was also analysed.

‡ The solid excreta of, say, Tuesday is supposed to belong to Monday's food, that of Wednesday to Tuesday, and so on; but as the urinary secretion is expelled more frequently, most of a day's urine belongs to the diet of that particular day, and in this paper is supposed to wholly belong to the same day.

Table II.—Reducing the various Foods tabulated in Table I to Food Equivalents.

|                                                    | Water.  | Albu-<br>minoids. | Carbo-<br>hydrates. | Fat.   | Ash.   |
|----------------------------------------------------|---------|-------------------|---------------------|--------|--------|
|                                                    | grms.   | grms.             | grms.               | grms.  | grms.  |
| Monday.....                                        | 3889·2  | 226·8             | 779·6               | 45·35  | 22·68  |
| Tuesday.....                                       | 3107·0  | 221·1             | 700·2               | 51·02  | 19·84  |
| Wednesday.....                                     | 4144·5  | 243·8             | 785·3               | 93·55  | 31·17  |
| Thursday.....                                      | 3696·6  | 246·6             | 887·2               | 45·35  | 19·84  |
| Friday.....                                        | 4110·5  | 240·9             | 847·5               | 87·88  | 19·84  |
| Saturday.....                                      | 3977·3  | 164·4             | 552·8               | 70·87  | 17·01  |
| Total.....                                         | 22925·1 | 1343·6            | 4552·6              | 394·02 | 130·38 |
| Mean of the six days.....                          | 3820·8  | 223·4             | 758·7               | 65·67  | 21·73  |
| Mean of five days, Saturday<br>being excluded..... | 3789·5  | 235·8             | 799·9               | 64·63  | 22·67  |

Table III.—Daily Average of Water-free Food taken by Mr. Weston as compared with a Standard Diet.

|                      | Standard<br>diet.<br>grms. | Average of<br>Weston's food.<br>grms. |
|----------------------|----------------------------|---------------------------------------|
| Albuminoids.....     | 98·46                      | 235·80                                |
| Carbohydrates.....   | 437·98                     | 799·90                                |
| Fat.....             | 47·40                      | 64·63                                 |
| Mineral matters..... | 24·37                      | 22·67*                                |

The albuminoids are therefore about 2·5 times that of an ordinary diet, and the carbohydrates and the fat nearly double.

#### *The Urine.*

The urine daily measured by Mr. Green, and forwarded to me, was always normal in colour, and contained neither albumin nor sugar.

Each sample was also tested for indigo by adding an equal bulk of strong hydrochloric acid and the proper quantity of bleaching powder, and then shaking up with chloroform; but in no instance could any evidence of indigo be obtained. By the time the urine reached me it had always undergone some ammoniacal decomposition, and any

\* The mineral matter is much too low, as is proved by the fact that the mineral substances excreted were in excess of the calculated ingested mineral substances; the explanation of which is that I have had no weights given me of the salt taken at meals, nor have I sufficient data for the mineral constituents of the broth, tea, coffee, and liquids drank.

ordinary estimation of urea would have given low results; it therefore appeared better to estimate the total nitrogen, and with certain deductions described further on to calculate out the urea from the data thus obtained. The total nitrogen was estimated by the moist process of combustion, first proposed, I believe, by Vijeldahl (*"Zeitsch. für Analytische Chemie,"* Heft 3, 1883), and recently submitted to a very exhaustive research as applied to urine by Dr. Petri and Th. Lehmann (*"Zeitsch. für Physiologische Chemie,"* Band VIII, Heft 3, 1884). It is a very accurate method of determining the total nitrogen in urine, in milk, and probably in most organic liquids, and will, without doubt, be much used.

Two grms. of the urine were placed in a flask, and 20 cub. centims. of pure sulphuric acid added; heat was applied by means of a small flame for two or three hours, at the end of which time crystals of permanganate were added until the liquid was first decolorised, and then given a distinct dark pink or red tint. On now alkalisising with pure soda, all the nitrogen present was distilled over as ammonia; the distillation being assisted by a current of hydrogen gas; the ammoniacal distillate was received in a known quantity of standard decinormal acid, and titrated back by decinormal soda, using as an indicator phenolphthaleïn.

The uric acid was determined in the usual way, viz., by concentrating half a litre of the filtered urine, strongly acidifying with hydrochloric acid, and, after twenty-four hours, collecting the crystals on a weighed filter.

The hippuric acid was estimated by adding some recently calcined magnesia to a litre of the urine, concentrating to a syrup, acidifying the syrup with hydrochloric acid, and extracting the acid liquid with ether.

The alkaloids (mostly kreatinine) were determined by acidifying with sulphuric acid, and then precipitating by phosphomolybdic acid; the precipitate was decomposed by baryta at a boiling temperature; the phosphomolybdate of baryta filtered off and well washed; the filtrate containing the urine alkaloids and baryta was saturated by carbon dioxide, boiled, concentrated, and filtered, the filtrate being evaporated to dryness and weighed; as there was still a trace of baryta, it was necessary to ignite, re-weigh, and to take the loss as representing the total alkaloids.

The urea, as before said, was not estimated directly, but was calculated from the total nitrogen after subtracting the nitrogen in the uric and hippuric acids and in the urine alkaloids; it may be a trifle over-estimated.

For the total solids 5 grms. of the urine were evaporated at 100° C. in a platinum dish, until the weight was practically constant. From a larger quantity concentrated to a syrup, the mineral matter was

Table IV.  
Analyses of the Urine of Mr. P. Weston during the Six Days he was under Observation.

|              | Urea.  | Uric acid. | Hippuric acid. | The urine alkaloids chiefly kreatinine. | Total nitrogen. | Phosphoric acid as phosphate. | Sulphuric acid (sulphates). | Chlorine. | Mineral matter. | Total solids. | Water.  |
|--------------|--------|------------|----------------|-----------------------------------------|-----------------|-------------------------------|-----------------------------|-----------|-----------------|---------------|---------|
|              | grms.  | grms.      | grms.          | grms.                                   | grms.           | grms.                         | grms.                       | grms.     | grms.           | grms.         | grms.   |
| Monday.....  | 66.55  | .48        | .83            | 3.22                                    | 27.30           | 4.83                          | 6.10                        | 23.00     | 70.84           | 125.50        | 2174.5  |
| Tuesday....  | 47.74  | .50        | .29            | .65                                     | 19.00           | 5.97                          | 5.37                        | 3.37      | 27.32           | 95.54         | 1844.4  |
| Wednesday..  | 53.93  | .26        | .14            | .48                                     | 21.25           | 6.76                          | 6.63                        | 14.98     | 32.74           | 107.00        | 2033.0  |
| Thursday.... | 63.39  | .14        | .24            | .23                                     | 24.80           | 5.81                          | 5.74                        | 11.59     | 24.28           | 93.20         | 1746.8  |
| Friday ..... | 63.44  | .53        | .37            | .66                                     | 25.13           | 5.60                          | 7.76                        | 13.23     | 27.21           | 87.88         | 1802.1  |
| Saturday.... | 56.05  | .53        | Undetermined   | 1.34                                    | 22.49           | 5.14                          | 5.96                        | 9.18      | 24.17           | 75.27         | 1454.7  |
| Total.....   | 351.10 | 2.44       | 1.87           | 6.58                                    | 139.97          | 34.11                         | 37.56                       | 75.35     | 206.56          | 584.39        | 11055.5 |
| Mean.....    | 58.51  | .40        | .37            | 1.09                                    | 23.32           | 5.81                          | 6.26                        | 12.57     | 34.42           | 97.39         | 1842.5  |

determined in the usual way. The methods used for estimating the other constituents were ordinary methods, and need not be detailed. Table IV gives the total excretion of the various substances mentioned, by the kidney, during each of the six days.

*Excretion of Sulphates and Organic Sulphur.*

As a subsidiary research, the sulphates were precipitated from a measured sample of the urine by barium chloride, and after the precipitate had been separated, the organic sulphur compound was broken up by saturating the liquid with chlorine. By this means, a second precipitate of barium sulphate was thrown down, and in the following table is calculated into organic sulphur.

Table V.—Amount of Sulphur as Sulphates and as Organic Sulphur separated daily, and compared with the Quantities of certain Foods.

|              | Sulphur<br>as<br>sulphate. | Organic<br>sulphur. | Total<br>sulphur. | Bread-<br>stuffs. | Albu-<br>minoids. |
|--------------|----------------------------|---------------------|-------------------|-------------------|-------------------|
|              | grms.                      | gm.                 | grms.             | grms.             | grms.             |
| Monday.....  | 2·79                       | ·068                | 2·858             | 392·57            | 226·8             |
| Tuesday .... | 2·47                       | ·485                | 2·955             | 396·74            | 221·1             |
| Wednesday..  | 3·02                       | ·565                | 3·585             | 595·52            | 243·8             |
| Thursday ... | 2·61                       | ·304                | 2·914             | 137·57            | 246·6             |
| Friday.....  | 3·52                       | ·362                | 3·882             | 651·03            | 240·9             |
| Saturday ... | 2·75                       | ·631                | 3·331             | 449·25            | 164·4             |

It is possible to arrive at the probable origin of the sulphur both oxidised and unoxidised, by arranging the days of the week in order so that the day of most sulphur excretion is at the top, of least sulphur excretion at the bottom; and then to take from Table I the several foods, and arranging them in a similar order to see whether there is any coincidence.

The days in the order of sulphur excretion are Friday, Wednesday, Saturday, Tuesday, Thursday, and Monday.

Since albumin constantly contains sulphur, the sulphates might be governed by the total albuminoids, but a glance at Table V will show that the albumin sequence is Thursday, Wednesday, Friday, Monday, Tuesday, and Saturday, which has no relationship with the sulphur sequence. It may be similarly shown that for a like reason, the liquids, the cabbages, the oatmeal, and all other constituents save the bread-stuffs may be excluded.

The toast, the bread, and the muffins (when taken) for each day

added together, and then the days arranged in order, show a very remarkable coincidence as follows, and renders it in the highest degree probable that the greater or less excretion of sulphates depended in Weston's case on the amount of bread-stuffs consumed.

| Ingestion of<br>bread-stuffs. | Sulphur<br>excretion. |
|-------------------------------|-----------------------|
| Friday .....                  | Friday                |
| Wednesday .....               | Wednesday             |
| Saturday.....                 | Saturday              |
| Tuesday .....                 | Tuesday               |
| Monday .....                  | Thursday              |
| Thursday .....                | Monday                |

*Note on the Urine Alkaloids.*

The alkaloids of the urine, especially kreatinine, have been variously considered as derived from metabolism of the living muscle, or from nitrogenous food. It is instructive to observe that the urine alkaloids in Weston's case were in excess on Monday, a day which followed twenty-four hours of complete rest, while during the rest of the week save Saturday, the amounts were rather below normal, the days arranged in series of most alkaloid down to least alkaloid are Monday, Saturday, Friday, Tuesday, Wednesday, Thursday, and this series shows no agreement with either the meat ingested or the broth. It would, therefore, seem that exertion, so far from increasing the excretion of the flesh bases, oxidises them up probably to urea.

*Fæces.*

The solid excreta for the five days, Tuesday to Saturday inclusive, were mixed as thoroughly as possible, and analysed as follows:—

A weighed portion was digested with strong alcohol to remove as much of the water as possible, the dehydrated residue was then exhausted in a Soxhlet's apparatus by ether; the alcoholic and ethereal extracts were united, dried, and weighed; the exhausted residue was also dried and weighed; the difference between the sum of these weights and the original was taken as representing the water. I may remark that I have always found the method detailed give more constant results than drying in the usual way.

The fat and cholesterin were extracted from a weighed portion by ether-alcohol, the volatile solvents being driven off, the extract was dried, redissolved by anhydrous ether-alcohol, and on evaporation weighed as fat and cholesterin; subsequently the cholesterin was extracted by saponifying the fat, and treating the soap with ether.

The fatty acids were extracted from the faecal soaps by acidifying with hydrochloric acid a portion of the excreta already freed from fat by ether, and then extracting with the same solvent. Combustions were made for nitrogen, carbon, and hydrogen.

Undigested starchy matters were determined by conversion into sugar by boiling with a dilute acid and then titrating with Pavy's ammoniacal copper solution. The whole analysis is as follows:—

|                                         |      | The solid excreta<br>(five days).<br>grms. |
|-----------------------------------------|------|--------------------------------------------|
| Water .....                             | 1695 | ·29                                        |
| Albuminoids .....                       | 309  | ·23                                        |
| Starchy matters .....                   | 47   | ·96                                        |
| Fat .....                               | 7    | ·76                                        |
| Fatty acids.....                        | 36   | ·77                                        |
| Cholesterin.....                        | 33   | ·35                                        |
| Cellulose and insoluble matters . . . . | 66   | ·69                                        |
| Ash .....                               | 86   | ·78                                        |
|                                         |      | <hr/> 2283                                 |
|                                         |      | ·83                                        |

### *Summary of Results.*

A good idea of the amount of food actually consumed, or used by the muscular mechanism, may be obtained by giving a sort of balance sheet between the food equivalents and the excreta, thus:—

|                 |        | Ingesta during<br>the five<br>corresponding days.<br>grms. |      |        | Egesta.<br>grms. |      |       | Difference.<br>grms. |
|-----------------|--------|------------------------------------------------------------|------|--------|------------------|------|-------|----------------------|
| Water .....     | 18,947 | ·8                                                         | .... | 11,296 | ·09              | .... | —7651 | ·7                   |
| Fat .....       | 323    | ·15                                                        | .... | 77     | ·88              | .... | — 245 | ·3                   |
| Carbohydrates.. | 3,999  | ·8                                                         | .... | 114    | ·65              | .... | —3885 | ·2                   |

The albuminoids in the food during the five days in which the total egesta were collected, amounted to 1179·2 grms., representing 186·2 grms. of nitrogen; the total nitrogen eliminated through the kidneys during the same period was 117·5 grms., and through the bowels 48·8 grms.; this subtracted from the nitrogen of the food gives a difference of 19·9 grms.; hence although all the nitrogen excreted is accounted for as derived from the food, some seems to have been retained, and the nitrogenous equilibrium was not quite perfect.

K. Vierordt ("Grundriss der Physiologie des Menschen," 1877) calculated on the assumption that 1 grm. of carbon completely burnt is equal to 8080 heat-units, and 1 grm. of hydrogen to 34,460 heat-

units, that the diet of a certain man consisting of 120 grms. of albuminoids, 90 of fat, and 330 of carbohydrates was equal to 2,922,011 heat-units; subtracting the carbon and hydrogen excreted in the fæces and urine, the heat-units of which were equivalent to 457,882, there were left 2,464,129 heat-units as representing the carbon and hydrogen which may be considered to have undergone complete combustion. A similar calculation gives the mean daily numbers of Weston's heat-units as 4,690,183, or just about twice the amount that Vierordt calculated for a man doing ordinary work on the standard diet given above.

Assuming the usual formula to be correct, that a person walking on a level surface raises  $\frac{1}{10}$  of his weight through the distance walked, then the work done by Weston daily in the Victoria Hall was equal to 2,462,071 kilogram-metres (793 foot-tons). It has usually been held that 1,552,795 kilogram-metres (500 foot-tons) daily was excessive labour, most ordinary work being little more than one-third of this.

Although for a limited time Weston himself, as well as others, has undergone more exertion, his feat is, I believe, the greatest recorded labour, if its continuity be considered, that any human being has ever undertaken without injury.

The Society adjourned over Ascension Day to Thursday, May 29th.